REMARKS

An excess claim fee for one (1) excess independent claim is included.

Claims 1, 4-5, and 8-21 are all the claims presently pending in the application. Claims 2-3 and 6-7 have been cancelled. Claims 1, 4-5, and 8 have been amended to more particularly define the invention. Claims 9-21 have been added to claim additional features of the invention.

No new matter has been entered.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claim 1 stands provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being allegedly unpatentable over claim 48 of co-pending Application No. 10/546,484. Claims 4, 5, and 8 stand provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being allegedly unpatentable over claim 48 of co-pending Application No. 10/546,484 in view of Harwig et al. ("Electrical Properties of β-Ga_2O_3 Single Crystals. II", Journal of Solid State Chemistry Vol. 23, pages 205-211, 15 January 1978).

Claims 1, 4, 5, and 8 stand rejected under 35 U.S.C. § 102(b) as being allegedly anticipated by Harwig.

The rejections mentioned above are respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

An exemplary aspect of the claimed invention (e.g. as recited in claim 16) is directed to a method of controlling a conductivity of a Ga_2O_3 system single crystal that includes adding a

predetermined dopant to the Ga_2O_3 system single crystal to obtain a desired resistivity, wherein the predetermined dopant comprises one of a n-type dopant for decreasing a resistance of the Ga_2O_3 system single crystal comprising one of Si, Hf, Ge, Sn, and Ti, and a p-type dopant for increasing a resistance of the Ga_2O_3 system single crystal comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Ca, Sr, Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, Tl, and Pb.

Conventional methods of controlling the conductivity of a Ga_2O_3 system single crystal have been used to control resistivity of the Ga_2O_3 system single crystal when a conductive property is required. Conventional methods, however, possess several different drawbacks. It is difficult using conventional methods to widely control the resisitivity because a substrate or thin film made of the Ga_2O_3 system single crystal naturally tends to have an n-type conductive property. It is also difficult using conventional methods to make a substrate or thin film of the Ga_2O_3 system single crystal having a high insulating property despite the necessity of such a Ga_2O_3 system single crystal (Application at page 3, lines 8-21).

On the other hand, an exemplary aspect of the claimed invention includes a method of controlling a conductivity of a Ga_2O_3 system single crystal that includes adding a predetermined dopant to the Ga_2O_3 system single crystal to obtain a desired resistivity, wherein the predetermined dopant comprises one of a n-type dopant for decreasing a resistance of the Ga_2O_3 system single crystal comprising one of Si, Hf, Ge, Sn, and Ti, and a p-type dopant for increasing a resistance of the Ga_2O_3 system single crystal comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Ca, Sr, Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, Tl, and Pb (Application at page 6, lines 14-19 and page 15, lines 13-23). This feature may provide a thin film or substrate with properties such as desired resistivity, controlled conductivity, and insulating properties (Application at page 6, line 13 to page 7, line 19).

II. THE NONSTATUTORY OBVIOUSNESS-TYPE DOUBLE PATENTING REJECTION

The Examiner alleges that claim 1 is obvious over claim 48 of co-pending Application No. 10/546,484. The Examiner also alleges that claims 2-5 and 8 are obvious over claim 48 of co-pending Application No. 10/546,484 in view of Harwig.

However, Applicant respectfully submits that none of the claims in co-pending Application No. 10/546,383 teach a method of controlling a conductivity of a Ga_2O_3 system single crystal that includes "*adding a predetermined dopant to the Ga_2O_3 system single crystal to obtain a desired resistivity, wherein said predetermined dopant comprises one of a n-type dopant for decreasing a resistance of the Ga_2O_3 system single crystal comprising one of Si, Hf, Ge, Sn, and Ti, and a p-type dopant for increasing a resistance of the Ga_2O_3 system single crystal comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Ca, Sr, Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, Tl, and Pb*", as recited, for example, in claim 1 (Application at page 6, lines 14-19 and page 15, lines 13-23). This feature may provide a thin film or substrate with properties such as desired resistivity, controlled conductivity, and insulating properties (Application at page 6, line 13 to page 7, line 19).

Further, as noted below, Harwig fails to make up for the deficiencies in claim 4, 5, and 8

Clearly, the co-pending Application's claim cited by the Examiner fails to teach this feature. Therefore, in view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw this rejection.

III. THE PRIOR ART REJECTIONS – The Harwig Reference

Harwig discloses the temperature dependence of the electronic contribution to the conductivity of doped Ga_2O_3 single crystals (Harwig at page 205). The Examiner alleges that Harwig teaches the claimed invention.

However, Harwig clearly fails to teach or suggest a method of controlling a conductivity of a Ga_2O_3 system single crystal that includes "*adding a predetermined dopant to the Ga_2O_3 system single crystal to obtain a desired resistivity, wherein said predetermined dopant comprises one of a n-type dopant for decreasing a resistance of the Ga_2O_3 system single crystal comprising one of Si, Hf, Ge, Sn, and Ti, and a p-type dopant for increasing a resistance of the Ga_2O_3 system single crystal comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Ca, Sr, Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, Tl, and Pb*", as recited, for example, in claim 1 (Application at page 6, lines 14-19 and page 15, lines 13-23).. This feature may provide a thin film or substrate with properties such as desired resistivity, controlled conductivity, and insulating properties (Application at page 6, line 13 to page 7, line 19).

The Examiner alleges that Harwig teaches a method for controlling a conductivity of a Ga_2O_3 system single crystal.

According to an abstract of Harwig on page 205, "[t]he influence of aliovalent dopants (Mg, Zr) on the electrical conductivity of quenched and equilibrated β-Ga_2O_3 single system crystals has been established. In the quenched crystals, frozen-in defects govern the electrical properties. In the quenched Zr-doped crystals, optical absorption by free charge carriers is observed in the infrared spectral region. Above 580 °K, the crystals can be equilibrated in air. Equilibration of the crystals markedly influences the electrical properties. In conjunction with data reported on undoped β-Ga_2O_3, it is proposed that the electronic conduction occurs via a hopping mechanism. The data reveal that doping influences the activation enthalpy for the conduction." (emphasis added)

In the conclusion on page 210, Harwig concludes that the electronic conduction occurs via a hopping-type process, implying a thermally activated electron mobility. In the hopping conduction, the carrier activated by the heat hops to an adjacent site such that the carrier moves between the molecules.

Harwig relates to the influence of the dopants on the electrical conductivity of quenched and equilibrated β-Ga_2O_3 single system crystals. However, Harwig does not explicitly teach or suggest a method of controlling conductivity of the Ga_2O_3 single system crystal by controlling the resistivity.

An exemplary aspect of the claimed invention, as defined by claim 1, and somewhat similarly by new claim 16, is characterized by doping a p-type dopant for enhancing the insulation property of a Ga_2O_3 single system crystal to obtain the p-type conductivity. In the Ga_2O_3 single system crystal according to the claimed invention, it is supposed that the electronic conduction occurs by the band conduction, in which a carrier is flown in a specific direction in a crustal lattice. Since the electronic conduction mechanism of the claimed invention is different from that of Harwig, it is not appropriate to speculate that Harwig teaches or suggests the method of controlling the conductivity Ga_2O_3 single system crystal according to the claimed invention.

In addition, Harwig fails to teach or suggest the limitations of claims 4, 5, and 8. The Examiner states that Harwig teaches the limitation of claim 4 on page 206. However, page 206 of Harwig fails to teach "*a value of $2.0 X 10^{-3}$ to $8.0 X 10^{2}$ Ωcm is obtained as the desired resistivity by adding a predetermined amount of said n-type dopant*", as is recited, for example, in claim 4 (Application at page 6, lines 21-24). The Examiner cites Figure 1 of Harwig as teaching this feature. However, Applicant respectfully submits that the Examiner is in clear error, as Figure 1 of Harwig clearly fails to teach this feature.

The Examiner states that Harwig teaches the limitation of claim 5 on page 209. However, page 209 of Harwig clearly fails to teach "*a carrier concentration of the Ga_2O_3 system single crystal is controlled to fall within a range of $5.5 X 10^{15}$ to $2.0 X 10^{19}/cm^3$ as a range of the desired resistivity*", as recited, for example, in claim 5 (Application at page 7, lines 5-11). The Examiner cites a table on page 209 of Harwig as having the aforementioned range of desired resistivity. However, the table clearly fails to teach this feature.

The Examiner stated that Harwig teaches the limitation of claim 8 at figure 1 on page 206 and on page 207. <u>However</u>, Harwig <u>clearly</u> fails to teach "<u>*1 X 10^3 Ωcm or more is obtained as the desired resistivity by adding a predetermined amount of said p-type dopant*</u>", as recited, for example, in claim 8 (Application at page 7, line 20 to page 8, line 2). The Examiner cites Figure 1 and page 207 of Harwig as teaching this feature. <u>However</u>, Applicant respectfully submits that the Examiner is in <u>clear</u> error, as Figure 1 and page 207 of Harwig <u>clearly</u> fail to teach this feature.

Therefore, Applicant respectfully requests the Examiner to reconsider and withdraw the rejection.

IV. NEW CLAIMS

New claims 9-21 have been added to claim additional features of the invention and to provide more varied protection for the claimed invention. These claims are independently patentable because of the novel and nonobvious features recited therein.

Applicant submits that the new claims are patentable over the cited prior art references at least for analogous reasons to those set forth above with respect to claims.

V. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1, 4-5, and 8-21, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for <u>allowance</u>. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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